NIOSH Mining Program Briefing Book
Executive Summary

Mining provides a large part of the energy and raw materials that feed this nation's economy. Copper pipe, concrete, and window glass serve as well-known examples of the reliance on minerals in modern society. Less appreciated, but as important, are the hundreds of mined commodities that are an integral and necessary part of everyday products, ranging from medicines and computers to carpet and paper. Coal is a major portion of the country's energy mix today, as it will likely continue to be in a future hydrogen-based economy. The domestic mining industry also provides strategic minerals that are important for the nation's security.

The processes to recover these mineral commodities are among the most demanding and complex in an industrial society, and historically this inherently dangerous industry has had the highest risks of fatality and injury. Our vision is to deliver on the nation's promise of safety and health at work for all people through research and prevention, and our mission is to eliminate occupational diseases, injuries, and fatalities from the mining workplace through a focused program of research and prevention. Our progress towards achieving our vision and fulfilling our mission is a major component of this review being conducted by the National Academy of Science.

The information compiled in this book tells the story of how we assess the safety and health needs of the mining industry, operationalize these needs into a focused program of research, and translate the research outputs into practice. Substantial evidence of our progress towards the ultimate goal of eliminating occupational disease and injury from the mining workplace is presented to document the impact of the research.

The organization of this book reflects four key areas of background information on the Mining Program:

1. What is the Mining Program?
2. What does the Mining Program do?
3. What has the Mining Program Accomplished?
4. What will the Mining Program Accomplish?

The answers to these four questions are contained in the four chapters into which this briefing book is organized.

Chapter 1 - What is the Mining Program?

The first question addresses the type of research conducted in the mining program and the resources that can be brought to bear on the execution of this research. The basis for the research is presented in the section entitled "Research Needs." The mining research plan is the first step in moving from the safety and health needs of the mineworker to research projects to

address those needs. This plan is described in the section entitled "Mining Research Plan." The resources available include the research staff, funding, and the laboratories and major equipment, and these are characterized in the sections entitled "Human Resources," "Funding," and "Physical Infrastructure," respectively.

The Mining Program is the program of research that has been planned and executed with a top-level goal to reduce occupational fatalities, injuries, and illnesses in mine workers. The program has the following characteristics:

- there are seven strategic goals, each of which contributes to achievement of the top-level program goal;
- the major gaps or barriers associated with each strategic goal are identified and used to constitute intermediate goals;
- new projects are developed and approved, based on their contribution to the accomplishment of an intermediate goal;
- project decisions are guided by a "critical path approach," i.e. the most direct path between research projects, intermediate goals, and strategic goals;
- resource allocation is guided by the overall state of the top-level goal, and, to a lesser extent, by progress towards strategic and intermediate goals, in an effort to optimize the overall program rather than individual strategic areas of the program; and
- there are performance measures to provide meaningful targets for researchers and to assess progress toward intermediate and strategic goals.

Mining research within the Institute began transitioning into this program-based approach in 2000. The strategic goal areas were originally called program areas, and intermediate goals were called overarching goals of the program area. With the advent of PART in 2003, the terminology was changed to strategic and intermediate goals, and performance measures were formalized. It is important to note that this transition to sector- and outcome-based programs is ongoing within the Institute, and has not been fully completed for the mining program.

Research projects that will directly or indirectly benefit mineworkers can be found throughout NIOSH. Some of these projects are part of an integrated program of respiratory disease studies, while others are part of a program of research in personal protective technologies. The majority of the projects focuses on the development of safety and health interventions, and is concentrated at the Pittsburgh and Spokane Research Laboratories. These projects are the ones that have been fully integrated into the "program" format. Accordingly, the information presented in this book is not an inventory of all NIOSH projects that may ultimately impact the safety and health of mineworkers. Rather, it focuses on those projects that were planned as a program of research in mining. Notwithstanding, many of these other projects are highlighted at appropriate points in this review. However, the basis for those projects as well as evidence of their impact will be presented in their Program Reviews, rather than as part of this Mining Program. At the staff level, collaborations run throughout the Institute, even though the major facility assets for conducting much mining research exist only within the Pittsburgh and Spokane Laboratories.

The Mining Program Plan, presented in this first chapter, defines the scope of the mining program through the seven strategic goals. The choice of the strategic and intermediate goals was driven by the needs of the customers and stakeholders. The next section of this chapter describes the basis for the Program Plan.

Chapter 2 - What does the Mining Program do?

The second question addresses the processes of developing and executing projects. The process of building and maintaining the research portfolio is described in the "Project Planning and Evaluation" section. The "Customers and Stakeholders" section identifies many of the customer and stakeholder groups who have significant interactions with the program in one or more of the following roles: drivers for the type of research and prevention activities in which we engage, consumers of our products and services, and collaborators in the conduct of our research projects. Many of our research collaborations are listed in the "Partnerships" section. This chapter is concluded with a compendium of the "mining" research projects, which provides a one-page description of each project.

The Mining Program conducts a focused set of research and prevention activities that has been designed to meet the needs of mineworkers and related stakeholders. The previous chapter explained the basis for the Program Plan and presented the Plan. This chapter summarizes the processes used to develop the research portfolio, the projects currently in the portfolio, and the customers, stakeholders, and partners of the Program.

The overall process beginning with defining and conducting the research and ending with effecting improvements to mineworker safety and health is complex. A logic model has been prepared to illustrate the more important interrelationships.

Chapter 3 - What has the Mining Program Accomplished?

The third question addresses the conversion of resources into useful products and services that have improved mineworker safety and health. The third chapter contains the evidence to support the contribution of the Mining Program to improvements in mineworker safety and health. Specifically, this chapter establishes causal relationships from research projects, outputs of these projects, and intermediate impacts created by project outputs, to the safety or health outcome. These outcomes are organized by strategic research goals.

This chapter addresses the improvements to mineworker safety and health that have been realized over the past ten years, and that have resulted from the research and prevention activities of the NIOSH Mining Program. It is often difficult to establish causal relationships between research activities and tangible gains in safety or health measures, and the process is further complicated by the fact that multiple organizations or individuals have contributed to the sequence of events that has effected the desire health or safety outcome. We have organized the relationships between our research activities and the ultimate health or safety improvement into three categories of outputs, intermediate impacts, and strategic program outcomes. Each of these will be defined here, and then additional remarks on who can rightly take credit for safety and health advancements will be offered in this introduction. Finally, the layout of this chapter is defined.

The execution of our research projects leads to defined deliverables or **outputs**. Outputs include papers published in peer-reviewed journals, articles in trade magazines, reports, workshops, and patents, among others. Each of these outputs has intrinsic value, but only to the extent that it is translated into practice. For example, a specific technology to reduce dust entrainment may be developed and demonstrated as part of a project. Papers may be written on this technology and workshops may be conducted. These are important outputs of the research, but until they are put into practice, they cannot have much impact. The next step is therefore to identify outputs that have been applied with some measurable success.

The successful application of multiple research outputs leads to an **intermediate outcome**. Continuing with our example, suppose that as a result of the papers and workshops to promote the newly developed technology, the industry adopts it. The translation of these research outputs into practice is a necessary, but not sufficient condition, to define an intermediate outcome. The second necessary condition is that putting these into practice will contribute to the solution of a desired safety or health problem. In our example, if the adoption of the dust control technology throughout the industry also results in reduced dust exposure to workers, then a logical basis exists to believe that this will have an impact on reducing dust diseases among mineworkers. Thus, the intermediate outcome in this example would be reducing dust exposure. We have chosen to label these outcomes as intermediate to emphasize that they are, in themselves, not the final goal, but rather an intermediate step to the ultimate goal of positively impacting the safety and health measures.

The realization over time of one or more intermediate outcomes leads to a desired safety or health **strategic program outcome**. Strategic program outcomes for the Mining Program are reductions in the occupational illnesses, injuries, and fatalities that affect mineworkers. Thus, in our example, a reduction in dust exposure, in conjunction with other intermediate outcomes, would be expected to lead to the strategic program outcome of a reduction in a lung disease associated with that dust. Of course, this final extension of the logic is more difficult to prove when the strategic program outcome, e.g. reducing coal worker pneumoconiosis, has a long latency period. Nonetheless, most experts would agree that a long-term reduction in exposure would have the desired outcome. The safety-based strategic program outcomes tend to be easier in this regard because the time period between the intermediate outcomes and the measurable changes in the desired strategic program outcome is shorter.

Our Mining Program Plan defines a set of seven **strategic goals**. Six of these relate directly to safety or health outcomes, and the seventh is a surveillance goal. For the purposes of organizing this chapter, the strategic program outcomes are classified by strategic goal. Accordingly, the accomplishments of the Mining Program are presented hierarchically, as follows:

The electronic version of this briefing book has hyperlinks to facilitate browsing the logical relationship of outputs to intermediate outcomes to strategic program outcomes to strategic goals.

Finally, there is the issue of determining the underlying causes of improvements to observable safety and health measures. At the output level, despite the often significant synergies among researchers at universities, private-sector research groups, and government agencies, it is usually straightforward to link a specific research project to a specific output. At the intermediate impact level, however, this becomes more difficult. NIOSH outputs can be linked to measurable intermediate impacts. However, in many cases the activities of others directly or indirectly contributed to those intermediate impacts. In most cases, multiple intermediate impacts are required to effect a change in the strategic outcome, and it is likely that NIOSH had involvement in only some of those. We are certain that NIOSH research and prevention activities have contributed to the measured improvements in mineworker safety and health. At the same time, we are certain that the activities of other non-NIOSH researchers have also contributed, and without the combined efforts of NIOSH and non-NIOSH researchers, these improvements would not have occurred. Moreover, the efforts of labor unions, industry groups, and enforcement agencies are absolutely essential to the process, and without their actions, little good would ever come of the research. For the purposes of this review, we have established plausible relationships between our past research activities and presently measurable changes in mineworker safety and health, and we have summarized the evidence that we believe supports these relationships. The remainder of this chapter presents those relationships and the supporting evidence.

Chapter 4 - What will the Mining Program Accomplish?

Finally, the fourth question addresses the future impact of the mining program. This last chapter is structured similarly to the previous chapter, which addressed past achievements, except that it attempts to show a plausible connection between recent and near-future project outputs and future intermediate and strategic program outcomes. Changes in our research planning processes to better integrate health-outcomes-based research planning with sector-based research planning are discussed in the "Strategic Planning" section of this chapter.

This chapter addresses the improvements to mineworker safety and health that are predicted to occur over the next five years as a direct result of the research and prevention activities of the NIOSH Mining Program. Many of the same issues discussed in the introduction to Chapter III apply here as well. Here, the forecasted accomplishments are based on: the critical assumption that resources and processes similar to the ones used over the past five years will continue over the next five years; the outputs that have occurred in recent years and appear to be on their way to an intermediate impact; and on-going project outputs, which are expected to lead to intermediate impacts.

The organization of this information is similar to the format used in the previous chapter. The potential outcomes section lists the seven strategic goals and the outcomes expected to be produced as the research results are implemented. A number of potential intermediate outcomes are listed, which are generally the outcomes expected from the currently active research projects if these are concluded successfully, and the results implemented by the intended customers. There are 4 to 16 potential intermediate outcomess for each strategic goal. For each of these potential intermediate outcomes there is a brief description of the problem, research approach, and the impact expected from the research. The research past and planned outputs, which will contribute to the potential outcome, are also listed with these descriptions.

The planned outputs section is a database of outputs which are expected to result from the current research projects or planned follow-up projects. The outputs are research products which communicate the results of the research to the public and potential users of the results. Each item in this database includes a title, year produced, type of output, and the strategic goal toward which it is directed. Many of these planned outputs will contribute to the achievement of the future potential intermediate impacts and are also listed with those items. The planned outputs are based primarily on current active research projects, and the outputs from these projects are expected in the next 2 or 3 years as most of these projects reach their planned conclusion. As a result, the number of planned outputs diminishes each year. We expect that the actual number of outputs will be the same or larger, if available resources remain the same. However, it is difficult to be specific in planning outputs from possible future research projects, which have not yet been formally proposed, reviewed or approved.

This briefing book is also available as a web-based document. In addition to the information provided in this hardcopy, the electronic version contains dynamic links to related information.